Title: Roller Coaster Mania

Brief Overview:

This unit provides students with opportunities for Internet research, as well as activities that allow for the application of previously-learned mathematics and writing skills. In addition, the unit engages students in scientific inquiry and introduces them to aspects of physical science.

NCTM 2000 Principles for School Mathematics:

- **Equity:** *Excellence in mathematics education requires equity - high expectations and strong support for all students.*
- **Curriculum:** *A curriculum is more than a collection of activities: it must be coherent, focused on important mathematics, and well articulated across the grades.*
- **Teaching:** *Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.*
- **Learning:** *Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.*
- **Assessment:** *Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.*
- **Technology:** *Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.*

Links to NCTM 2000 Standards:

- **Content Standards**

Number and Operations
Students will demonstrate their ability to convert actual size measurements to a scale of choice and then state actual size measurements from a given scale. They will use estimation to round their results in specific calculations. Students also will demonstrate applications of estimation when determining various features of their roller coaster. They will use various unit rates and proportions to derive average roller coaster speed.

Geometry
Students will demonstrate their understanding of spatial reasoning to construct a scale model of a roller coaster from the selected features of their choice. They will measure and use knowledge of angles to determine the most appropriate angle of decline in order for their roller coaster to achieve maximum speed.

Measurement
Students will demonstrate their ability to use a ruler in measuring various lengths of a scale drawing and determine the actual size of the roller coaster track. They will employ measurement skills in converting units of time from minutes to seconds.

Data Analysis and Probability

Students will demonstrate their data collection and reasoning capabilities by gathering information about roller coasters and then making comparisons with other students' data. They will analyze their data to develop hypotheses about specific characteristics of roller coasters and the effect on the overall "thrill" aspect of the ride. Students will use data and reasoning to determine specific dimensions and features to install within their own roller coaster. They will determine speed of a roller coaster using given statistics about the roller coaster.

- **Process Standards**

Mathematics as Problem Solving, Reasoning and Proof, Communication, Connections, and Representation

These five process standards are threads that integrate throughout the unit, although they may not be specifically addressed in the unit. They emphasize the need to help students develop the processes that are the major means for doing mathematics, thinking about mathematics, understanding mathematics, and communicating mathematics.

Students will demonstrate their ability to utilize data that they collected and knowledge about mathematical and scientific concepts in developing their own roller coaster. They will decide which factors and features are necessary to design a roller coaster with the most thrilling ride possible. Through data analysis and group comparisons, they also will determine which features affect a roller coaster's overall speed. Students will use problem solving abilities in deciding what will happen to various aspects of the roller coaster when specific features are altered. They will be utilizing various scientific concepts throughout the unit. These concepts may be developed further depending upon class knowledge and ability. Students will use all of their findings to create their own roller coaster and then explain the features to an expert in a letter.

Links to National Science Education Standards:

- **Unifying Concepts and Processes/Physical Science**
  Students will learn about many of the physical forces affecting the design, construction, and operation of roller coasters and other amusement park rides. Some of these forces will include: inclination, acceleration, centrifugal force, gravity, and friction.

Grade/Level:

Grade 8

Duration/Length:

Five - six class periods (including assessment)

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- Estimating, rounding, and place value
- Calculating mean, median, mode, and range
- Collecting, organizing, and representing data
- Number operations using decimals and whole numbers
- Writing a business letter
- Measuring with a ruler in inches
- Calculating and using scale measurements

- Measuring angles

Student Outcomes:

Students will:

- analyze data and make decisions based on a variety of influences and factors.
- write to inform.
- create a scale drawing.
- complete tables.
- measure angles.
- calculate the rate of speed.
- measure objects using a ruler.

Materials/Resources/Printed Materials:

- Ruler
- String (6 inches long)
- Markers (Blue/Red)
- Protractor
- Calculator
- Internet (or copies of roller coaster data sheet)

Development/Procedures:

Day One:

- Materials: Questionnaire on Roller Coasters (Worksheet #1).
- Students are given Questionnaire on Roller Coasters (Worksheet #1) to complete individually.
- Teacher leads class discussion about Questionnaire emphasizing what makes roller coasters thrilling (height, speed, duration, angle of drop, type of coaster, restraining devices, environment, etc.)
- Organize students into groups of four or fewer. Have them compare the roller coaster designs they sketched on the back of their questionnaire. Some things the groups should focus on are: safety, feasibility, angles, length, ride duration, and speed.

Day Two:

- Materials: Computers for Internet Search or copies of roller coaster data table, Collecting Data on Roller Coasters (Worksheet #2), Radical Roller Coasters Data Sheet (Worksheet #2A), and ruler.
- This portion of the lesson can be completed having students utilize a search engine on the Internet to find their own data, or the teacher may make copies of and use the table found in the database website **www.rcdb.com** to have students gather information.
- Prior to students collecting any data, they should be placed in groups and near each other while doing their collection.
- Students will need Collecting Data on Roller Coasters (Worksheet #2) and Radical Roller Coasters Data Sheet (Worksheet #2A).
- Students will initially be working alone to choose their own roller coaster and to collect the data for their coaster. Following their collection, they will share their information with group members and record it on their data sheet.
- Teacher should lead a discussion on the conclusions and interesting facts that individuals and groups have discovered through their research.
- Portions of the worksheet may be assigned for homework depending upon class time.

Day Three:

- Materials: Finding the Average Speed (Worksheet #3), and calculator (teacher discretion).
- In groups or individually, have students use Finding the Average Speed (Worksheet #3) to determine the mean speed of given roller coasters.
- Teacher should lead discussion on student findings and conclusions from activity.
- Teacher should ask students to compare speeds found from the Internet search to the speed the students calculated. (Speed from Internet search is top speed to look more impressive. Students calculated average speed of the entire ride.)
- Teacher should lead discussion about safety factors that need to be considered in relation to height of drop and speed. (Number of people in car and ability to stop if needed - laws of motion, the type of track after a steep hill - can not be too curved if speed is too fast, etc.)

Day Four:

- Materials: Scale Drawing of Roller Coaster (Worksheet #4), ruler, calculator (teacher discretion), string (6 inches long), markers (blue and red), and protractor.
- In groups, students will work on Scale Drawing of Roller Coaster (Worksheet #4). This activity is to help students understand the actual length of a roller coaster taken from a picture using scale and identifying how the angle affects the length of the downhill track.
- After students have completed the scale portion of the worksheet, the teacher should discuss and compare group answers prior to working on Part II of the worksheet using the string.
- While groups are working with string, teacher should walk around the room to assist groups having difficulty with the directions.
- After students have completed the string exercises, the teacher should lead a discussion on conclusions and findings from the activities.
- Students should begin the last section of the worksheet to discover how angle measurements affect the length of the downhill track. Depending upon student skill level, this activity may be done as a class with the teacher modeling the steps. (This activity also could become a homework assignment depending upon time restraints.)
- The teacher should lead a discussion on the findings and conclusions from the activities once all groups are completed.

Performance Assessment:

Students will be asked to help a fictional amusement park increase its sales by designing a new roller coaster. They will go through six steps in order to complete their roller coaster design. They also will need to use their knowledge of maximum hill height, speed, angle of descent, safety, and ride duration to complete a planning sheet. Students will draw a sketch of their anticipated roller coaster. They will work with a partner to evaluate each other's sketches and give feedback on the feasibility of their planned roller coaster. Once feedback is received, students will create a scale drawing of the highest hill in their coaster and then draw that portion of their design to scale on the given graph paper. The assessment will conclude with students writing a business letter to a roller coaster club requesting feedback about their design. Rubrics are included for the assessment pages to check on mathematics and language arts performances.

Extension/Follow Up:

- Students can create a web page displaying their roller coaster design.
- Students can create a three dimensional model of their scale drawing.
- Science classes can become involved in the learning unit according to local curricula.
- Students can plan a field trip to visit a local amusement park.
- Depending upon ability level, students can graph the duration of a the roller coaster to its maximum speed and then discuss and match graph appearance to images of the roller coasters.

- Depending upon the ability level, the class can further investigate physical scientific concepts such as speed, momentum, gravity, friction, and slope as they relate to roller coasters.
- Classes can experiment with roller coaster design by studying the interactive website at **www.Funderstanding.com/k12/coaster.** This extension would be best utilized after the unit but prior to the assessment.
- Watch the Discovery Channel video on Roller Coasters as an introduction to the unit.

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Teacher's Resource Sheet

A search for "roller coaster" on Yahoo! (www.yahoo.com) yielded almost 150 sites in several categories.

The following websites may be most helpful:

1. www.rcdb.com	Lists data for many coasters at various parks.
2. www.Funderstanding.com	Contains a model within which the student can control a number of variables and observe the results.
3. www.learner.org/exhibits/parkphysics	Student can make choices in "building" a coaster. Then, he/she receives an evaluation of the construction.

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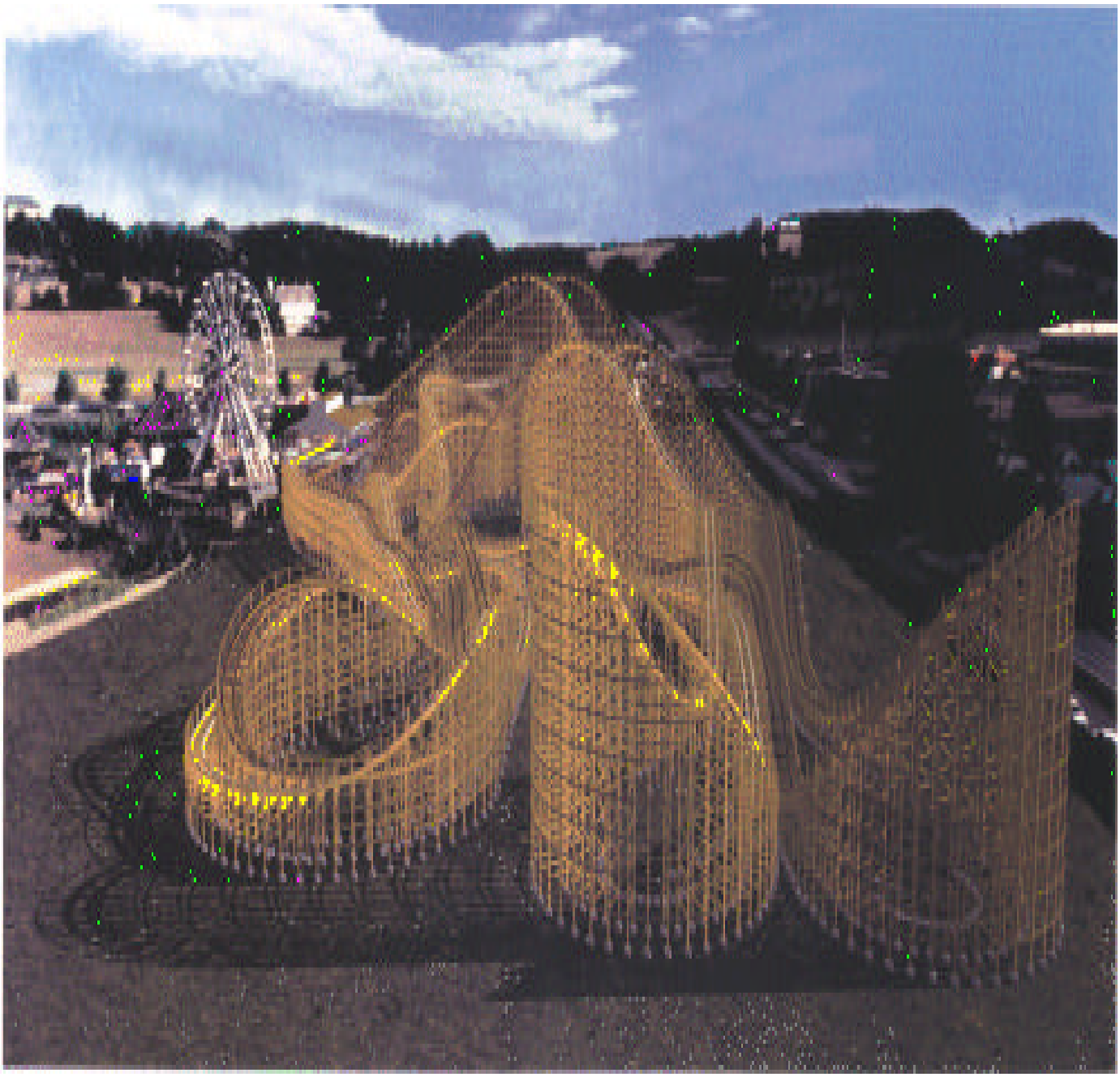
Roller Coaster Mania



Worksheet #1

Questionnaire on Roller Coasters

Name_____

Answer each question below as fully as possible. If you need additional space, you may use another sheet of paper

1. Have you ever visited an amusement park? _____
2. List any amusement parks you have visited.

_____

_____

_____

3. Which rides usually have the longest lines? Why?

_____

_____

4. What rides do you think are the most exciting? Why?

_____

_____

_____

5. Do you enjoy riding roller coasters? Explain your response.

_____

_____

_____

6. What do you know about the relationship between a roller coaster's height and its speed?

_____

_____

_____

7. Explain how you think a roller coaster works.

_____

_____

_____

8. Use the back of this sheet to sketch a roller coaster and label any parts possible.

Worksheet #2A

Radical Roller Coasters

Name _____

Directions: Fill in the table with the data that your group collected.

Name of Roller Coaster	Location (Park, State)	Track Length	Top Speed	Maximum Drop	Ride Duration	Rider Capacity

Worksheet #2B

Collecting Data on Roller Coasters

Name_____

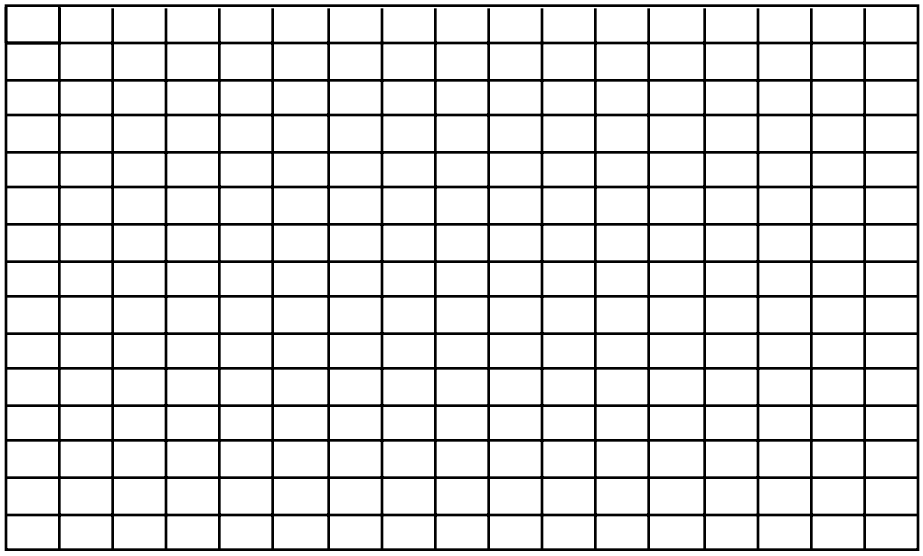
Directions: Using the Internet, answer all of the questions. Each group member needs to gather information about a different roller coaster.

1. Search the Internet for any amusement park in the United States.
2. List the name of the website for the amusement park. _____
3. List the name of the amusement park and where it is located.

   _____
4. Search the website for a roller coaster which gives you specific information needed to fill out the chart on the worksheet entitled Radical Roller Coaster . DO NOT ACTUALLY COMPLETE THE CHART YET!
5. List the name of the roller coaster you have located. _____
6. Compare the names of roller coaster with your group members. No roller coaster may be represented twice in the same group. If two or more group members have located the same roller coaster, those group members must do another search.
7. After each member has a different roller coaster, complete the table on Radical Roller Coaster Worksheet based upon the data from your roller coaster.
8. Record the data of all of your group members onto the table.
9. Draw some conclusions about the data your group collected about Roller Coasters. Be sure to include similarities and differences between data.

   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____

10. Create a scatter plot on the given graph paper representing the maximum height and the top speed of the roller coasters from your group. Be sure to label the axis, and use a title and appropriate scale. (Hint: maximum height, top speed)



11. List three conclusions you can draw based upon the graph. Use appropriate mathematical reasoning and vocabulary.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

12. As a group, determine the mean and range for each category listed below. Complete the table on the next page. Show all necessary work.

	Mean	**Range**
Track Length (feet)		
Maximum Height (feet)		
Top Speed (miles/hour)		
Duration (minutes)		
Ride capacity		

TEACHER COPY
Worksheet #2B

Collecting Data on Roller Coasters

Name_____

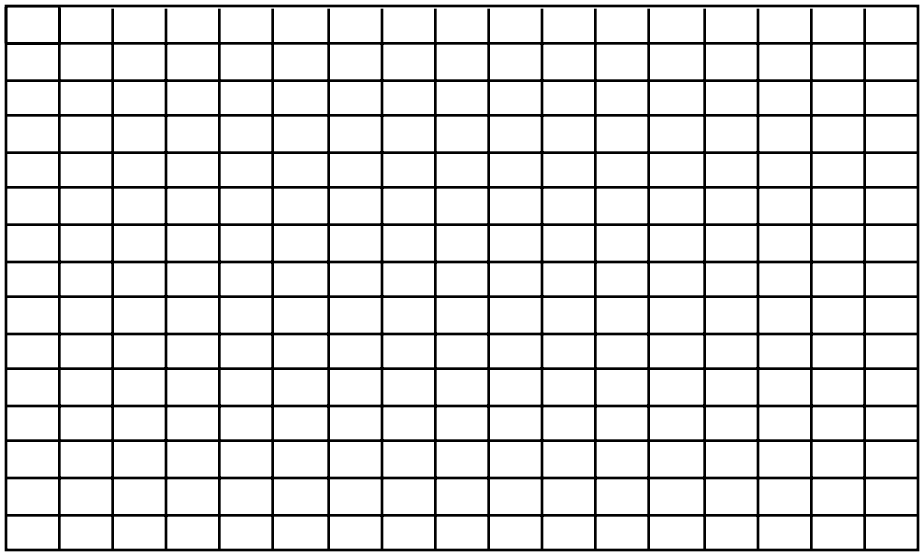
Directions: Using the Internet, answer all of the questions. Each group member needs to gather information about a different roller coaster.

1. Search the Internet for any amusement park in the United States.
2. List the name of the website for the amusement park. _____
3. List the name of the amusement park and where it is located.
   _____**ANSWERS WILL VARY.**_____
4. Search the website for a roller coaster which gives you specific information needed to fill out the chart on the worksheet entitled Radical Roller Coaster . DO NOT ACTUALLY COMPLETE THE CHART YET!
5. List the name of the roller coaster you have located. **ANSWERS WILL VARY.**
6. Compare the names of roller coaster with your group members. No roller coaster may be represented twice in the same group. If two or more group members have located the same roller coaster, those group members must do another search.
7. After each member has a different roller coaster, complete the table on Radical Roller Coaster Worksheet based upon the data from your roller coaster.
8. Record the data of all of your group members onto the table.
9. Draw some conclusions about the data your group collected about Roller Coasters. Be sure to include similarities and differences between data.

ANSWERS WILL VARY - SOME SUGGESTED RESPONSES INCLUDE: THE HIGHER THE HILL, THE FASTER THE SPEED; LONGER THE TRACK, LONGER THE RIDE DURATION; LOCATION OF ROLLER COASTERS; THE FASTER THE SPEED, THE SHORTER THE RIDE, ETC.

10. Create a scatter plot on the given graph paper representing the maximum height and the top speed of the roller coasters from your group. Be sure to label the axis, and use a title and appropriate scale. (Hint: maximum height, top speed)

ANSWERS WILL VARY - HORIZONTAL AXIS IS MAXIMUM HEIGHT; VERTICAL AXIS IS TOP SPEED.



11. List three conclusions you can draw based upon the graph. Use appropriate mathematical reasoning and vocabulary.

ANSWERS WILL VARY - SOME SUGGESTED RESPONSES INCLUDE: THE HIGHER THE HILL, THE FASTER THE SPEED (POSITIVE RELATIONSHIP).

12. As a group, determine the mean and range for each category listed below. Complete the table on the next page. Show all necessary work.

ANSWERS WILL VARY

	Mean	**Range**
Track Length (feet)		
Maximum Height (feet)		
Top Speed (miles/hour)		
Duration (minutes)		
Ride capacity		

Worksheet #3A

Finding the Average Speed

Name_____

Directions: Using the information provided in the table below, calculate the speed of the roller coasters. Follow the example, and watch your units.

Name	Track Length (feet)	Duration	Average (feet/second)
Magnum XL200	5106	2 min	
The Villain	4000	45 sec	
Son of Beast	7032	1 min 10 sec	
Goliath	4500	3 min	
Apollo's Chariot	4882	2 min	
Millennium Force	6595	2 min	

Ex.: Name = Kumba
Length= 2780 ft.
Duration = 1 min. 45 sec.

1) Change minutes to seconds. 1 minute = 60 seconds 60 + 45 = 105 seconds

2) Divide track length by duration of ride. $\frac{2780 \text{ ft}}{105 \text{ sec}}$

3) Round to tenths. 26.476 to 26.5 ft/sec

Worksheet #3B

1. Compare the lengths of track to the durations. What comparisons can you make?

_____

_____

_____

2. Using the table and your calculations, what hypotheses can you determine based on the length/duration and the speed of the ride?

_____

_____

_____

3. Based on the table and your knowledge of roller coasters, which roller coaster from the table has the largest maximum drop? How did you determine this?

_____

_____

_____

_____

Teacher Copy
Worksheet #3A

Finding the Average Speed

Name _____

Directions: Using the information provided in the table below, calculate the speed of the roller coasters. Follow the example, and watch your units.

Name	Track Length (feet)	Duration	Average (feet/second)
Magnum XL200	5106	2 min	**42.55 rounds to 42.6 ft/sec**
The Villain	4000	45 sec	**88.8... rounds to 88.9 ft/sec**
Son of Beast	7032	1 min 10 sec	**78.13... rounds to 78.1 ft/sec**
Goliath	4500	3 min	**25 ft/sec**
Apollo's Chariot	4882	2 min	**40.683 rounds to 40.7 ft/sec**
Millennium Force	6595	2 min	**54.958 rounds to 55.0 ft/sec**

Ex.: Name = Kumba
Length = 2780 ft
Duration = 1 min 45 sec

1) Change minutes to seconds. 1 minute = 60 seconds 60 + 45 = 105 seconds

2) Divide track length by duration of ride. $\frac{2780 \text{ ft}}{105 \text{ sec}}$

3) Round to tenths. 26.476 to 26.5 ft/sec

Teacher Copy
Worksheet #3B

1. Compare the lengths of track to the durations. What comparisons can you make?

ANSWERS WILL VARY - SUGGESTED RESPONSES

THE LONGER THE TRACK, THE LONGER THE RIDE

2. Using the table and your calculations, what hypotheses can you determine based the length/duration and the speed of the ride?

ANSWERS WILL VARY - SUGGESTED RESPONSES

THE LONGER THE TRACK, THE LONGER AND FASTER THE RIDE

3. Based on the table and your knowledge of roller coasters, which roller coaster from the table has the largest maximum drop? How did you determine this?

ANSWERS MAY VARY AND ARE DEPENDENT UPON JUSTIFICATION.

MOST COMMON ANSWER - SON OF BEAST

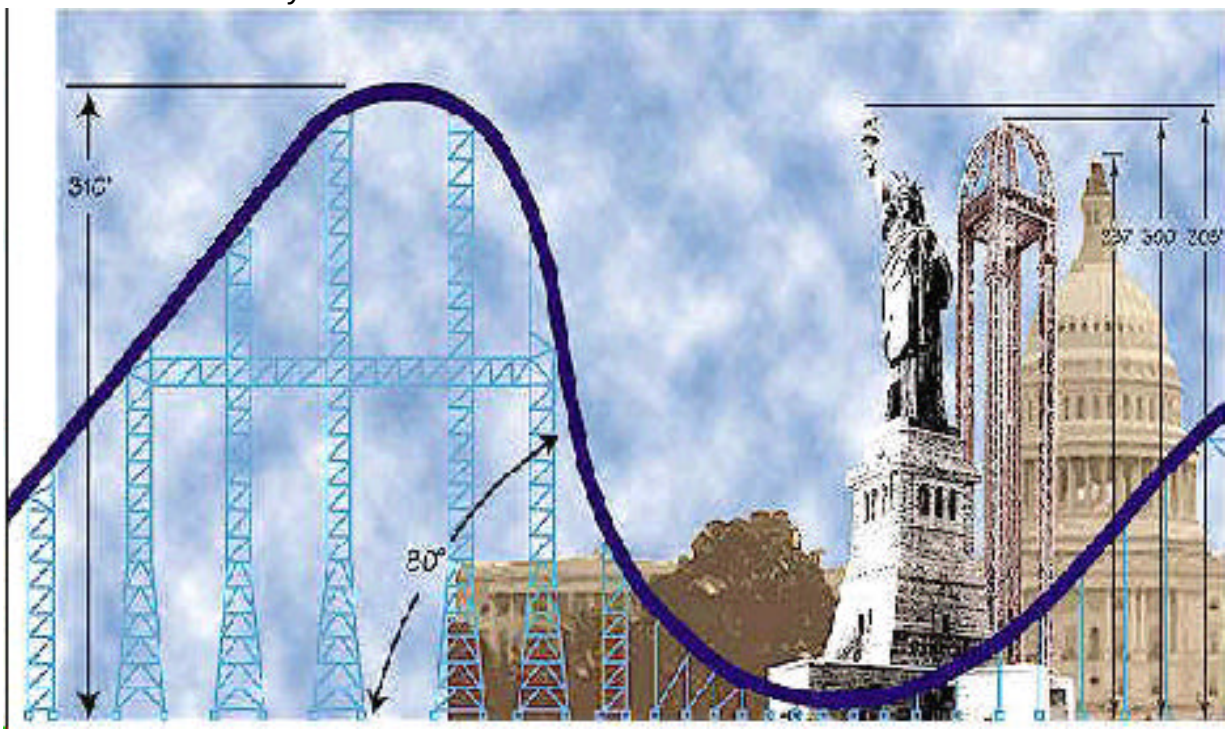
LONGEST TRACK, FASTEST SPEED AND SECOND FASTEST DURATION WHICH MEANS IT MUST HAVE A STEEP DROP TO GET UP ENOUGH SPEED TO QUICKLY MOVE AROUND A LONGER TRACK.

Worksheet #4

Scale Drawing of Roller Coaster

Name _____

Directions: Below is a scale drawing of a portion of the Millennium Force, a roller coaster located in Cedar Point Amusement Park in Ohio. Answer the questions that follow and show all work on additional paper. Remember to always include units!



Part I. Measuring

1. What is the maximum height of the roller coaster? _____

2. What is the height of the Statue of Liberty? _____

3. What is the height of the Capitol building? _____

4. A Pepsi Can is 5 inches tall. If you stacked the cans on top of each other, how many cans would be needed in order to reach the maximum height of the roller coaster?

   _____

5. Using inches on a ruler, measure the maximum height of the roller coaster in the picture. _____

Part II - Scale

6. To determine the scale of a picture, you need to calculate how many feet each inch represents. Determine the scale of the picture. For example, if the building is actually 100 feet tall but in the picture it is only 2 inches, your scale would be : 1 inch represents 50 feet. _____
7. Extend the initial uphill track so that it now touches the ground (bottom of the picture). Remember not to change the slope of this line, so use a ruler to continue the track.
8. Lay your string perfectly over the entire initial uphill track and the entire downhill track. Do not cover any of the track that begins to slope back up.
9. Starting at the bottom of the initial uphill track, trace the string which covers the uphill portion of track with a blue marker. Stop at the maximum height of the roller coaster.
10. Starting from the maximum height of the roller coaster, trace the string which covers the downhill portion of the track with a red marker. Stop at the lowest point before it begins to slope back upward.
11. Place the string on your desk in a straight line. Using inches on your ruler, measure the blue portion of your string. This represents the initial uphill portion of the roller coaster from the picture. Record your measurement.

    _____
12. Using the scale you discovered in question #5, how long is the actual initial uphill track in feet? _____
13. With the string still straight and flat on your desk, measure the red portion of the string using inches on your ruler. _____
14. Using the scale you discovered in question #5, how long is the actual downhill

Part III - Angles

15. The angle of a roller coaster is formed from the steepest part of the track and the ground. Using the picture of the roller coaster, what is the angle measurement of the Millennium roller coaster? _____
16. Lay your string over the picture of the roller coaster. Make sure that the blue portion of the string is covering the entire portion of the initial uphill track.

17. Decrease the angle of the roller coaster on the downhill portion of the track. Move your string to resemble the new angle of the roller coaster. Measure your new angle. New Angle: _____

18. What happens to the length of the downhill track when the angle decreases?

_____

_____

_____

19. How will a decreased angle measurement affect the speed of the roller coaster?

_____

_____

_____

_____

_____

20. Increase the angle of the roller coaster on the downhill portion of the track. Move your string to resemble the new angle of the roller coaster. Measure your new angle. New Angle: _____

21. What happens to the length of the downhill track when the angle increases?

_____

_____

_____

_____

_____

22. How will an increased angle measurement affect the speed of this portion of the track? _____

_____

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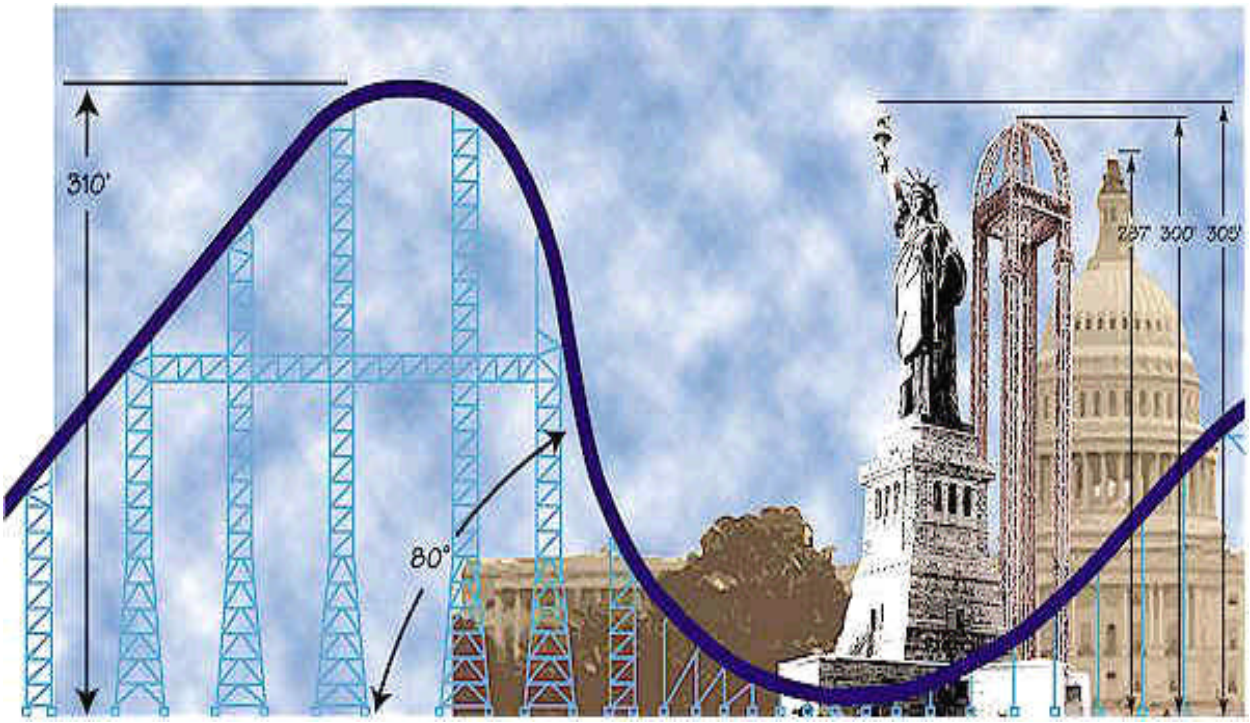
Worksheet #4

Scale Drawing of Roller Coaster

Name _____

Directions: Below is a scale drawing of a portion of the Millennium Force, a roller coaster located in Cedar Point Amusement Park in Ohio. Answer the questions that follow and show all work on additional paper. Remember to always include units!



Part I. Measuring

1. What is the maximum height of the roller coaster? **310 FEET**
2. What is the height of the Statue of Liberty? **305 FEET**
3. What is the height of the Capitol building? **237 FEET**
4. A Pepsi Can is 5 inches tall. If you stacked the cans on top of each other, how many cans would be needed in order to reach the maximum height of the roller coaster?

   744 CANS OF PEPSI
5. Using inches on a ruler, measure the maximum height of the roller coaster in the picture. **3.25 INCHES**

Part II - Scale

6. To determine the scale of a picture, you need to calculate how many feet each inch represents. Determine the scale of the picture. For example, if the building is actually 100 feet tall but in the picture it is only 2 inches, your scale would be : 1 inch represents 50 feet. **1 INCH = 95.38 FEET**
7. Extend the initial uphill track so that it now touches the ground (bottom of the picture). Remember not to change the slope of this line, so use a ruler to continue the track.
8. Lay your string perfectly over the entire initial uphill track and the entire downhill track. Do not cover any of the track that begins to slope back up.
9. Starting at the bottom of the initial uphill track, trace the string which covers the uphill portion of track with a blue marker. Stop at the maximum height of the roller coaster.
10. Starting from the maximum height of the roller coaster, trace the string which covers the downhill portion of the track with a red marker. Stop at the lowest point before it begins to slope back upward.
11. Place the string on your desk in a straight line. Using inches on your ruler, measure the blue portion of your string. This represents the initial uphill portion of the roller coaster from the picture. Record your measurement.
    4.5 INCHES
12. Using the scale you discovered in question #5, how long is the actual initial uphill track in feet? **429.23 FEET**
13. With the string still straight and flat on your desk, measure the red portion of the string using inches on your ruler. **4.125 INCHES**
14. Using the scale you discovered in question #5, how long is the actual downhill portion of the track in feet? **393.46 FEET**

Part III - Angles

15. The angle of a roller coaster is formed from the steepest part of the track and the ground. Using the picture of the roller coaster, what is the angle measurement of the Millennium roller coaster? **80 DEGREES**

16. Lie your string over the picture of the roller coaster. Make sure that the blue portion of the string is covering the entire portion of the initial uphill track.
17. Decrease the angle of the roller coaster on the downhill portion of the track. Move your string to resemble the new angle of the roller coaster. Measure your new angle. New Angle: __**ANSWERS WILL VARY.**_
18. What happens to the length of the downhill track when the angle decreases?
    YOUR TRACK LENGTH MUST INCREASE IN ORDER FOR THE HILL TO COME BACK DOWN TO THE SAME DISTANCE ABOVE THE GROUND._
19. How will a decreased angle measurement affect the speed of the roller coaster?
    A DECREASED ANGLE WILL CAUSE THE DOWNHILL TRACK TO BE LESS STEEP AND THIS WILL ALSO DECREASE THE TOP SPEED OF THE ROLLER COASTER AND THE AVERAGE SPEED OF THE ROLLER COASTER. THE SMALLER THE ANGLE, THE SLOWER THE SPEED._
20. Increase the angle of the roller coaster on the downhill portion of the track. Move your string to resemble the new angle of the roller coaster. Measure your new angle. New Angle: __**ANSWERS WILL VARY.**_
21. What happens to the length of the downhill track when the angle increases?
    YOUR TRACK LENGTH MUST DECREASE IN ORDER FOR THE HILL TO COME BACK DOWN TO THE SAME DISTANCE ABOVE THE GROUND._
22. How will a increased angle measurement affect the speed of this portion of the track? _**AN INCREASED ANGLE WILL CAUSE THE DOWNHILL TRACK TO BE MORE STEEP, AND THIS ALSO WILL INCREASE THE TOP SPEED OF THE ROLLER COASTER AND THE AVERAGE SPEED OF THE ROLLER COASTER. THE LARGER THE ANGLE, THE FASTER THE SPEED.**_

Assessment

Situation: Rocky Run, a failing amusement park in your community, needs help. The attendance at the park has been steadily declining and there isn't enough revenue to keep the park open for much longer. The owners of the park have determined that a new roller coaster would increase park attendance and create the revenue needed to help the amusement park survive. Your expertise in roller coasters is needed to design such a coaster. Follow the steps below to create your design. When your design is complete, write a letter to The Mid-Atlantic Coaster Club asking them to critique your design.

Step 1: Complete the planning sheet on Assessment Page 1 for the roller coaster you wish to design.

Step 2: Make a rough sketch of your entire roller coaster design.

Step 3: Get feedback from a partner about your design.

Step 4: Make revisions to your sketch

Step 5: Create a scale drawing showing the ascending and descending track of your largest hill and drop.

Step 6: Write your letter.

Planning Sheet

Physical Dimensions	
Track Length	
First Hill Height	
Second Hill Height	
Third Hill Height	
Design	
Type	
Time	
Features	
Passenger Cars	
Ride Capacity Per Hour	
Ride Manufacturer	

Sketch Area

Directions: In the space below, sketch the design of your roller coaster. Include the physical dimensions from your planning sheet and the appropriate information about design. Pay special attention to the first hill's height and angle of decline.

Peer Feedback Sheet

Designer _____ Reviewer _____

Provide thorough and specific comments to each of the categories below.

1. Is the design realistic? _____

Comment:

_____

_____

_____

_____

2. Does the sketch contain all the necessary components of the roller coaster design as outlined on the planning sheet? _____

Comment:

_____

_____

_____

_____

3. What is one design aspect you like? _____

Comment:

_____

_____

_____

4. What is one design aspect that needs improvement? _____

Comment:

_____

_____

_____

Scale

Directions: Before you make your scale drawing, you need to determine the appropriate scale. Examine your graph paper and your planning sheet. Determine a reasonable scale based on your information. Below, **show and explain** how you arrived at your scale. Be sure to include your scale on your design.

Work Area

Explanation:

_____

_____

_____

_____

_____

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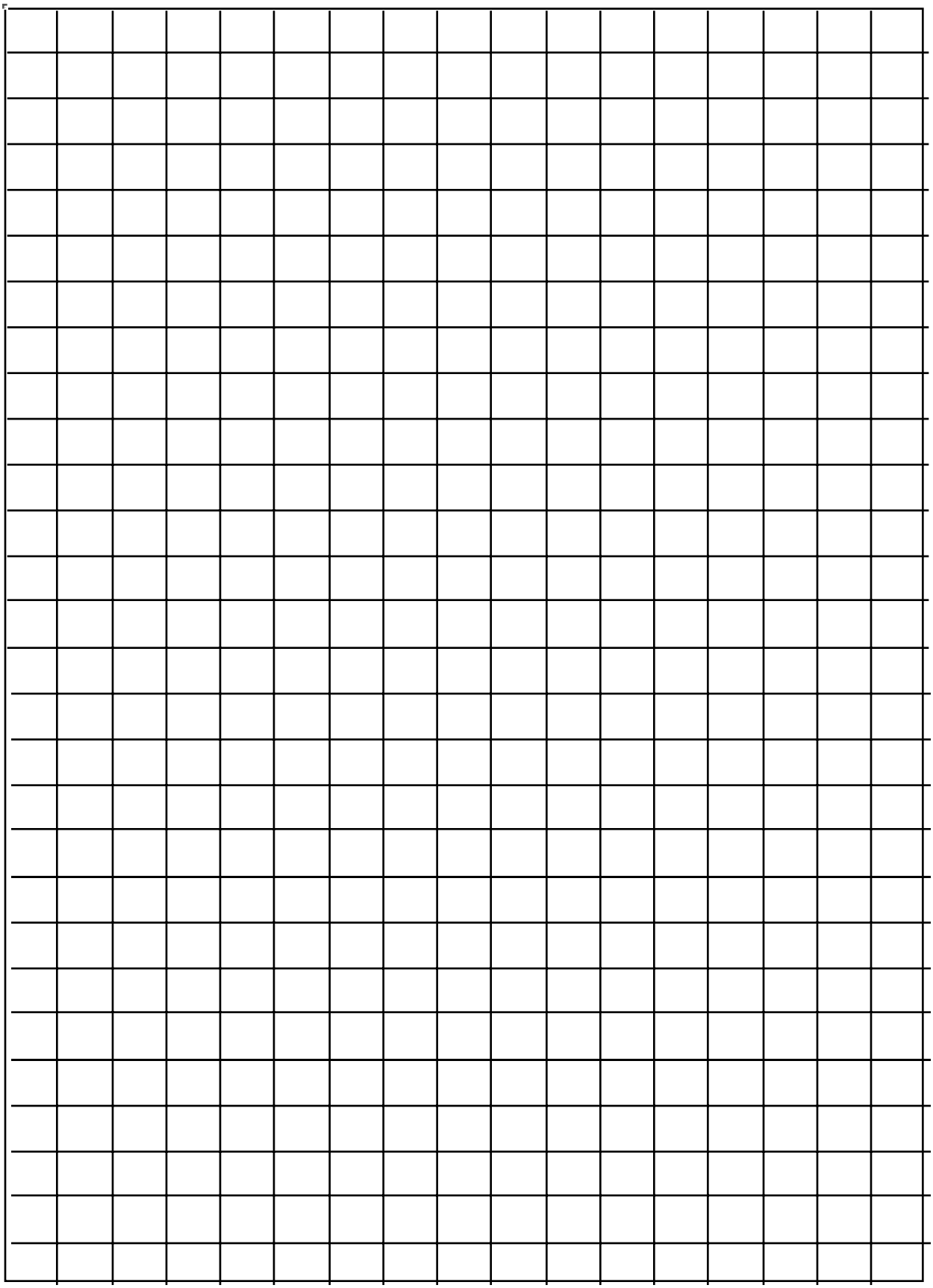
_____

_____



Letter

In the space below, write a letter to Mid-Atlantic Coaster Club, 7532 Murillo Street, Springfield, Virginia 22151. Ask them to provide feedback on your roller coaster design. Be sure to include information on the physical dimensions and the design itself . Explain why your coaster will improve attendance at Rocky Run. Justify your design based on the work we have completed this week (track length, height of hill, speed, angle of decline, safety, and ride capacity). Be sure to use proper business letter format, correct grammar, and mechanics.

Rubric for Scoring Language Arts Content

3 Points -

- Student demonstrated complete understanding of the following skills: punctuation, capitalization, grammatical usage, and syntax.
- Student accurately wrote the letter using proper business letter format.
- Student included all required information in the body of the letter.
- Student displayed ability to use accurate and succinct language to discuss the roller coaster design.

2 Points -

- Student demonstrated partial understanding of the following skills: punctuation, capitalization, grammatical usage, and syntax.
- Student completed the letter with minimal errors using business letter format.
- Student included most required information in the body of the letter.
- Student displayed moderate ability to use accurate and succinct language to discuss the roller coaster design.

1 Point -

- Student demonstrated a limited understanding of required grammatical skills.
- Student completed the letter with many errors in business letter format.
- Student included partial required information in the body of the letter.
- Student displayed limited ability to use accurate and succinct language to discuss roller coaster design.

0 Points -

- Student demonstrated little understanding of required grammatical skills.
- Student did not complete the letter using business letter format.
- Student did not include required information in the body of the letter.
- Student was unable to use accurate and succinct language to discuss roller coaster design.

Rubric for Scoring Math Content

3 Points -

- Student demonstrated complete understanding of the following skills: addition, subtraction, multiplication, and division.
- Student determined realistic dimensions and features for the roller coaster design.
- Student successfully calculated the scale for the roller coaster design.
- Student designed and constructed accurate scale drawings and models.

2 Points -

- Student demonstrated partial understanding of the following skills: addition, subtraction, multiplication, and division.
- Student determined somewhat realistic dimensions and features for the roller coaster design.
- Student calculated the scale for the roller coaster design with minimal errors.
- Student designed and constructed mostly accurate scale drawings and models.

1 Point -

- Student demonstrated limited understanding of the following skills: addition, subtraction, multiplication, and division.
- Student determined dimensions and features for the roller coaster design that were mostly unrealistic.
- Student calculated the scale for the roller coaster with many errors.
- Student designed and constructed mostly inaccurate scale drawings and models.

0 Points -

- Student demonstrated little understanding of the following skills: addition, subtraction, multiplication,and division.
- Student determined unrealistic dimensions and features for the roller coaster design.
- Student incorrectly calculated the scale for the roller coaster.
- Student designed and constructed unrealistic scale models and drawings for for the roller coaster design.

Teacher Copy

Physical Dimensions	
Track Length	5106 feet
First Hill Height	205 feet
Second Hill Height	157 feet
Third Hill Height	80 feet
Design	
Type	Out-and-back coaster
Time	Approximately 2 minutes
Features	First hill drop of 60 degrees Lap bar restraints Three tunnels with special effects
Passenger Cars	Six, six-passenger cars on each train for a total of 36-passenger trains
Ride Capacity Per Hour	Approximately 2,000 riders per hour
Ride Manufacturer	Student Name or Created Company Name

Peer Feedback Sheet

Designer _____ Reviewer _____

Provide thorough and specific comments to each of the categories below.

1. Is the design realistic? **Yes/ No**

Comment: **Sample Response**

The design shows realistic proportions. The angles for the hills are appropriate for the height and vertical drop. Or,the design is unrealistic. The angles are too steep for the hill design shown. With the current design, the ride would be unsafe.

2. Does the sketch contain all the necessary components of the roller coaster design as outlined on the planning sheet? **Yes/ No**

Comment: **Sample Response**

This sketch shows all the information from the planning sheet. It is thoroughly completed. Or, the following information from the planning sheet has not been transferred to the design: height of third hill, angle of decline, and passenger cars.

3. What is one design aspect you like? **Answers will vary.**

Comment: **Sample Response**

I liked that a loop was included after the second hill. This will make the coaster more exciting and draw visitors to Rocky Run.

4. What is one design aspect that needs improvement? **Answers will vary.**

Comment: **Sample Response**

I think that the first hill needs to be larger in height so that the ride is more exciting and the coaster will be able to make the ascent on the next hill.

Teacher Copy
Assessment Pages 4 & 5

Scale

Directions: Before you make your scale drawing, you need to determine the appropriate scale. Examine your graph paper and your planning sheet. Determine a reasonable scale based on your information. Below, **show and explain** how you arrived at your scale. Be sure to include your scale on your design.

Work Area

Sample Response based on the following data from planning sheet:

Hill one: 205 feet

Height of hill in centimeters: 20 centimeters

$$\frac{\text{20 cm}}{\text{205 ft}} = \frac{\text{1 cm}}{\text{10.25 ft}}$$

scale: 1 cm = 10.25 ft

Explanation:

In order to determine my scale, I took the height of the first hill that I recorded on my planning sheet and I looked at my graph paper to see how I could draw this. I chose to make the first hill 20 centimeters. Then I made a ratio (fraction) comparing the numbers. I reduced the ratio (fraction) until I could see how much one centimeter would equal.

Letter

In the space below, write a letter to Mid-Atlantic Coaster Club, 7532 Murillo Street, Springfield, Virginia 22151. Ask them to provide feedback on your roller coaster design. Be sure to include information on the physical dimensions and the design itself . Explain why your coaster will improve attendance at Rocky Run. Justify your design based on the work we have completed this week (track length, height of hill, speed, angle of decline, safety and ride capacity). Be sure to use proper business letter format, correct grammar and mechanics.

Sample using block form; modified block is also acceptable

444 Sunny Dale Road
Annapolis, MD 21403
December 1, 2000

Mid-Atlantic Coaster Club
7532 Murillo Street
Springfield, VA 2151

Dear Sir or Madam:

I am a middle school student who has been studying roller coasters and roller coaster design in my math class. I was asked to design a coaster for an amusement park that needs to increase its attendance. I have enclosed my design for you to review. I hope you can take some time to provide feedback to me.

My roller coaster, Thudercat, has a track length of 5,106 feet. The design shows the initial hill and its angle of decline. According to my calculations, the hill will be 205 feet. The angle of decline is 60 degrees. The second hill, which is not shown on the scale drawing, is 157 feet high. I believe with the speed from hill one, the coaster will not have any trouble making the next ascent. I believe this steep drop will make for an exciting ride and draw people to visit the amusement park.

I have also taken safety concerns and overall design into consideration. Thudercat will be designed with lap bar restraints to ensure rider safety. The coaster also will have three special effects tunnels to add to the excitement of the ride. The coaster will have three operating trains with a total capacity of thirty-six passengers for each train. This will ensure that the line for the coaster will move at quick pace, ensuring a short wait for passengers.

I would greatly appreciate your time and effort in critiquing my design. Any feedback from a roller coaster enthusiast would be beneficial. Please send your comments to the address above. Thank you for you time.

Sincerely,
Signature
Skip 4 spaces
Signature